1. A computer cannot set its own standards

Numerical calculations achieved through computers rest on the fact that computers use a simulant of the real number system thus inevitably introducing a floating model unlike classic theories that employ inductive and deductive models. A floating model - whatever high capacity it may have necessarily carries with it roundoffs and this paves the way for pitfalls in computation. Let us consider a toy computer in which numbers x are represented in the form.

$$x = \pm (d_1 d_2 \ldots d_s)\, \beta^s$$

$$\text{with } 1 \leq d_1 \leq \beta - 1, \quad \emptyset \leq d_i \leq \beta - 1$$

$$\text{for } i = 2,3, s \text{ and ; let } \beta = 10, \; s = 5$$

Computation of exp (-5.5) through the above computer using the expansion for exp (x) and retaining 25 terms gives the result

$$\emptyset . \emptyset\emptyset\ 26\ 363$$

and compared to the value of exp (-5.5) (= Ø.ØØ4Ø8677 to eight decimal digit accuracy) the result in (2) is only 36% accurate. The source of the error is the catastrophic cancellation inherent in the algorithm used in the computation and invoking the fact that exp (-5.5)=1/exp (+5.5), one obtains on the same computer the result [Ø.ØØ4Ø865) wherein the error is impressively brought down to Ø.ØØ7%. How much worse the situation is if we need the calculation exp (-1ØØ) by the earlier algorithm? It would be a catastrophe. In this instance of computing the exponential function the programmer has the prior knowledge of the function he is dealing with and any wrong signal from the computed result can be checked and cross checked. In the course of any computation the computed result is to be examines in the course of any computation the computed result is to be examined in the light of known behavior of the function or the geometry of the problem (or any well-founded principle) like the principle of energy or the second law of thermodynamics. In other words the computing team has a certain standard against which the calculation can be checked. The standard steams from the classics i.e., classical theories arising from concepts developed with clarity and logical analysis. Fields like genetic alteration and the physics of high energy particles have no such standard and research in such cases rests on semi-empirical guess and uncontrolled numerical computation. There is no knowing if and when something goes wrong in the computation. Reliance on such numerical calculations without the resource of standards is suspect and is dangerous. The same mathematical problem may lead to

different answers on different machines and an ugly remedy to avert this is to employ just one machine and place faith in whatever be the result emitted by it. The same problem may be solved by different codes and then even on one and the same machine different answers are possible. Should there be serious discrepancy 'bench mark code' is applied to select which among the different computing answers is closest to the true solution known in some simple case. Thus, again one has to appeal to classics for help. Benchmark problems are simple and the correctness of code in some known case should not breed confidence that it is accurate for all hitherto unsolved problems also. The true solution of the unsolved problem may be essentially different and far more complicated and delicate. e.g. The small oscillation solution and the solution without the assumption of smallness in the motion of a simple pendulum illustrates the above point. In the field of fluid mechanics the nature of the solution is distinctly different for flows with low Reynolds number and flows with high Reynolds number. The rightness of the code for high Reynolds number flows cannot be decided, no matter how abundant the computation is. Computers can be intelligently employed in the context of theories that are already well understood. However, reposing confidence in the computer exploration of unknown domains is dangerous. Cosmetic efforts like adopting multiple precision in the calculations and widening the range of parameter values. will not and should instil confidence in the computed results. Daily application of pure Silvikrin at a very early stage may arrest hair thinning in some cases, but this should not warrant the wishful thinking or belief that with larger dosage and more frequent application one has a cure for baldness.

Whether a code is correct for a problem posed to the computer for solution is not answerable in the absence of a classic theory and a clear grasping of the various phenomena inherent in the problem. A classic theory is not a compilation of facts any more than heap of bricks is a house. " One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity " -J WILLARD GIBBS. A theory is itself a model of nature in action and the problem for solution is replaced by a model problem that can be formulated to ensure acceptability by the computer. The computer may lead to the correct solution of the problem but how can one be certain of it in the absence of a theory, a standard for guidance in the matter ? A computer code replaces any problem assigned to it for solution by a finite algebraic system and calculations through such systems have a tendency to smoothen the features. What is possibly a catastrophe in the correct solution may be blurred or

completely hidden by the smoothening operations of the computer. A particular, regular, gradually varying solution via the computer may be a consequence of numerical diffusion and a shock or discontinuity in the correct solution may be image processed into a smooth pattern by the computer. This is an instance of gross abuse of the computer. This abuse is double-ended and surprising indicators, indicators of near explosion may be wrongly attributed to instability arising from numerical diffusion while in reality there may be near catastrophe in the computed solution. The back drop of computer solutions that ultimately led to the identification of solitons in 1965 illustrates amply the extent to which the abuse of the computer poses a threat to the development of scientific theories.

2. Spatial flight would have been impossible without the computer; equally certain it is that the program could not have started without the classic theory of mechanics inaugurated by NEWTON (1642-1727), organized and chiseled into shape by EULER (1707-1785) and systematized and extended by LAGRANGE (1736-1813)

The launching of man into parts of space where he becomes weightless and moves like a planet and being ejected from his newly acquired orbit and given moon weight instead of his earth weight, is landed on the moon and later rising and reversing his voyage earthward, is brought back on earth constitute a spectacular event of the success of technology. Long before such a voyage, each step of it is planned carefully to the minutest detail and every change of motion is contrived with precision and every mechanical or human error is corrected and a revised program is effected. All this sounded fanciful hardly thirty five years back. Without the computer interplanetary flight would not have been possible. The computer undertakes the routine task of numerical calculation and does it swiftly, copiously, accurately and as directed. Numerical calculation is not to be mistaken for mathematics. Success of interplanetary travel and many other activities enabled by the computer would not have started without the coordination of the many steps involved to push the programme upto the final stage. The computer cadets that run the programmes are to be guided continuously regarding the quantities to be calculated, the equations to be solved, the coefficients to be determined from experiments, the controls to be imposed on the experiments and the initial conditions to be obtained experimentally or assigned intelligently. These cannot be tackled by the computer by itself. A pile of integrated circuit chips cannot flash out orders continuously directing

and adjusting man's voyage to the moon. The mechanics of the motion that provides the conceptual bones of the programme, the central equations that the computer is to solve again and again with millions of different initial conditions and diverse empirical parameters were obtained by great men that pondered the massive results of astronomical observations and applied their naked and disciplined minds to the discovery of the simple laws that operate among the maze of numbers. The differential equations governing the motions of point masses and rigid bodies were the cumulative contributions of Newton, Euler and Lagrange. Apart from these, there were other phenomenon like the physics of gases and heat and radiation, meteorology, the chemistry of fuels and biological and medical experiences man may have to pass through in the project of manned flight. It was a spectacular triumph of applied science but all this would not have been possible by computers alone without the directions and checks from classic science. The news media attributes the triumph to the computers without reference to the role of the classics.

3. Mathematics is the Science of Infinities and of Limiting Process. Computer is essentially finite.

A problem for computation and a problem solved by mathematics are two distinct notions. A single arithmetic step calculated by a rapidly convergent algorithm can deliver to many correct decimal digits an approximation to the solution x of the equation $x^2 = 2$. A set of useful algorithms along with rigorous error estimates have to be worked out by an expert in numerical analysis if the computer solution has any useful role. Even after the maximum number of decimal digit calculations for an approximation to the solution, the computer does not and cannot convey the message that x is irrational, a fact known to mathematicians and proved almost two thousand years ago. No computer can ever handle irrational numbers.

About sixteen years back the news media bleated the message that the computer had solved a famous problem that had baffled mathematicians for almost one hundred years. The reference was to the FOUR COLOUR PROBLEM which is easily understood, viz. it is possible to colour a planar map with four colours. In view of the infinitely many maps that are possible, a computer solution by testing every map is out of question and the report of computer having solved the problem is FALSE. Regular, traditional mathematics could be used to reduce the problem of FOUR COLOUR MAPPING to the investigation of a finite number of instances and it is because of this reducibility to a finite number of cases by

APPEL and HAKEN that the computer could be used to resolve the problem. This finite number was very large and human effort without the aid of a machine could not be thought of. Even so the algorithm for the calculations was a consequence of human thinking. Theorems established over the years by an array of mathematicians had to be invoked to construct the algorithm and the news media did not mention the essential mathematics that was used in the successful reduction of the problem to a format where the use of the computer could be thought of. It was an unintended or calculated fraud motivated by the high priests of the computer that there was complete absence of reference to the dominant role of mathematics in resolving the question. The computer was here a servant to mathematics, may be a good servant. A nasty doubt remains. Did the machine make one little mistake? No one knows until some mathematician answers this through a set of logical ideas without the intervention of black boxes. An alternative scenario is possible. Were there two mistakes each of which annulled the effect of the other ? Such mistakes are possible among mathematicians and rechecking by them or others will be necessary. Work of this nature through a computer cannot be checked logically and in the first place appeal to the computer shows the surrender of logic in favour of the routine, a routine that is so long that no human can follow it even once. The referees of the paper of APPEL and HAKEN resorted to an independent computer programme to check the correctness of the reducibility calculations. Assurance of reliability from this independent check is no doubt valuable in view of its psychological effect. Mathematicians trained before the computer era and those with training during the computer era may still doubt as to why there should be problems that cannot be solved without a combination of logical analysis and computation that is not possible for humans alone.

Computation on fast machines certainly deserves wider acceptance by mathematicians but its products are no more than guesses towards what can be proved and any view contrary to this is not justifiable. Problems that at first and for a long time thereafter require numerical computation, may indeed have a purely mathematical solution without the need to use numerics. The evaluation of KOEBE´s constant is one such instance.

The famous problem of the non-existence of integers x,y,z such that $x^p + y^p = z^p$ where p is an odd prime integer (FERMAT´S LAST THEOREM) has baffled mathematicians for nearly three hundred years. "..... one is in the position of being able to prove Fermat´s Last Theorem for virtually any prime number p within the computational range, but one cannot

rule out the possibility that the theorem is false for all primes beyond some large bound". (HAROLD M.EDWARDS - Fermat's Last Theorem - Springer-Verlag,1977). This clinches any doubt that may be there regarding computing and mathematics. Computation does not settle a question except by way of pointing the falsity of a proposition by a counter example.

The essential finiteness of computation thus puts mathematics beyond the reach of computing. There are other areas of science which are also beyond the reach of the computer. In the motion of a real or artificial satellite the differential equations of motion operate under certain limits and such limits are never within the reach of a computer. One may hope for discrete approximations to such limits and no one knows if the approximations are accurate. Without the structure of the exact problem, there is no way to decide the order of accuracy of the approximation and the number of decimal digits retained in the calculation is not always an index of the order of accuracy when there is no a-priori concept of exactness.

The test of accuracy is in the mind of the analyst of the mathematical problem who assigns it for solution by the computer. "Qualitative Analysis" is a mathematical development of the post computer era through which the mathematician demonstrates precise bounds for the effects of variation of the data to be provided by experiments or else the person directing the investigation prescribes them. Qualitative Analysis can classify the parameters into those wherein the parameter changes are ineffective on the outcome and those wherein parameter changes significantly, influence the outcome. The parameters of the latter class need to be measured with precision or assigned with great care lest there should be violent or chaotic alterations in the end results from the computer. Computers are totally helpless in the matter of identifying the two classes of the parameters. The computer may at best provide the effects of some special choices of parameters and even then, whether these are typical or not will not be known. We may be able to graph a few points constituting a scatter diagram with no indication of the limits within which the graph should lie.

Now an illustration from a different field.

In a study on the approach to equilibrium of a Boltzman-Equation solution (1981) the authors resorted to extensive computation to verify a conjecture making the entropy a completely monotonic function of the time. For a 'wide time range' they found that the first thirty derivatives of the

entropy had the right sign "with double precision, significant to 33 figures". One year later, it was pointed out by Prof.ELLIOT LIEB through rigorous analysis using a half-a-century-old mathematical theorem that the conjecture was indeed false. The greatest care in the use of computers is called for in the study of delicate mathematical properties. It was estimated later that for a computer to be able to arrive at the correct conclusion in the above problem, calculation of the first 1Ø2 derivatives is needed. Computers do often give useful hints about the properties of solutions to analytic problems. However, in the event of the property under investigation being delicate, more computer time is needed. Analyticity and complete monotonicity are highly subtle properties requiring infinite computer time, a situation that cannot be met in reality.

Under the direction of competent mathematicians computation can indeed offer help by way of providing a numerical example that concretizes an abstract statement or disproving a false guess or accumulate material that may suggest a conjecture to be examined mathematically later. Fine plotting of graphs can make mathematical statements visual. Parts of mathematics reducible to finite arithmetical routines can be successfully handled by computers.

4. Computers bring Power and with it also the abuses of power. Advocates of computation destroy mathematics

The specialists garrisoned around a big computer are highpriests of computation and are not bothered about the cost in various measures that unmitigated computation involves. The hundreds of thousands of programmers and system analysts (in U.S. alone their number had crossed 5ØØØØØ (Five Lakhs) in 198Ø) that form the commissioned officers of the computer army are well aware that numbers bring power and computing is incessantly promoted by advertising and fabulous amounts are directed for computer design and manufacture. Whether every problem that comes up for computation out of genuine necessity and whether one or several of them cannot be critically analyzed mathematically is of no concern to them. The wealth that gravitates towards the computer industry brings also power along with it and then its inevitable abuse. The computer folk will not settle for peaceful coexistence with the intellectual mathematicians - by far the only source that can generate informed criticism of computer worship - and seek profit and enjoyment in deprecating every mathematical pursuit that is not numerical.

Early in this century NIELS BOHR and ALBERT EINSTEIN presented their theories that revolutionized physics but this did not end all the old problems of classical mechanics. Instead, there were new sets of problems. The faculty in physics in the twenties of this century were mostly trained in classical physics and to cope with the new scenario, some had to retrain themselves by learning quantum mechanics and relativity. The rest of them remained wherever they were and in a single academic generating the classicists became a microscopic minority.

The change experienced now in mathematics is as dramatic and irreversible as the one in physics about seven decades back and if there is any single cause for this change of scenario and possible destruction of mathematics, it is the emergence of the computer.

A violent shakeup may be expected in the main stream of mathematical activity in another generation and topics like numerical analysis, Operations Research and Statistics will usurp the pride of place. Only mathematics which is computer-oriented will receive financial support and like Newtonian Mechanics in the earlier era, conventional topics of mathematics will be elbowed from the centre stage in mathematics departments. This may be resisted for some time but the bulk of mathematicians will be using computers in their work or will be busy with questions pertaining to the advanced development of computer algorithms. Mathematics as an outfit of the human thought process over the last three thousand years will be face to face with the computer that descends on it as a thunderbolt and the resulting cultural revolution renders every branch of science into discretization and invoking the computer becomes a normal act.

Calculus and connected areas involve questions of limits inherently beyond numerics and so will have to vacate from the central scene in mathematical education. Mathematics as an activity of the human mind will not have many defenders what with democracy even in academics, that decides issues through opinion polls. As in political democracy, even here opinion poll may be staged and manipulated by mass media.

It may be mentioned in passing that in the last century one of the European Countries' Legislature was toying with the idea of <u>resolving by legislation</u> that the number is rational.

5. Computers have promoted fraud and have damaged experimental and applied science

True science seeks methods for solving important questions and a method invented in a certain context, can be used for resolving problems in other areas as well and new applications may follow. Computation is just one such method but the computer addicts speak as if it is an imperial pill that cures all diseases. No need for diagnosis, no dosage, no monitoring of effects and side effects. The bigger the dosage, the better it is for all.

We often read in the press that one computer does the work of a thousand and more mathematicians. Nothing can be more wrong. The thousands of persons whose services are replaced by the computer are computationists. Such work is welcome to society in areas like financial accounting, traffic analysis, traffic control, spying by tax officers, some aspects of engineering design, meteorological charts, medical analysis and a host of other activities prevalent in a modern state. Like some other gadgets, the computer does work of a routine nature which nobody likes to do and work of this type grows daily to colossal scales in accordance with Parkinson's law. It is here that a computer does the greatest good to society.

If creative mathematics becomes extinct, there may not be many eyes wet with tears. But it is not just mathematics only that is killed by computer addiction. Computer codes are sold or even distributed gratis by the promoters of computer industry and these are often applied blindly/ignoring all the warnings to users. Fraudulent exploiters promise their clientele to solve for a fee any problem and deceive the public in the process. A charlatan in medicine has to be circumspect lest he should be treated to third degree methods by or on behalf of the victim(s) but a computer charlatan has no such handicaps. Many experimental programmes today feed their data directly into a computer and recovery of the data is not easy in view of the horrid mass/mess of numbers. Skilled hands can easily make computers lie. Even the data is fudged. When the stake is high and publicity in the media is tempting, succumbing to manipulations is irresistible and no auditors can certify the authenticity or the lack of it in the book of accounts. The computer discourages attempts to understand before applying and smoothens the way for factual fraud. Even if the data is recoverable computers can give contrary interpretations of them. Some years back, there were two conflicting pictures extracted by "computer-enhanced imaging" from the same data in a project involving the exploration of the face of Mars

by two different groups of computer experts. Group A found grey fog - the usual reward of the astronomers. Group B claimed to penetrate the clouds and discover beneath them a huge face in a desert pocked by pyramids. If the work of group B is genuine, the report of group A shows the untrustworthiness of the computer interpretation of data. If the work of Group B is a hoax, obvious it is that computer experts are not trustworthy. In the meanwhile, the face of Mars-whatever be the truth about its features-will continue in its own way. The computer is then programmed to remove the 'noise' that blurs the image but with no prior criteria to determine what is noise and what is the faint trace of a record of some object whatever be the truth about the diorama of Mars, the threat to man that trusts science ruled by computers and computer experts is there for all to see. One can see the effect of computer enhanced imaging of spy photographs of weapons stockpiled by potential enemies. There may be a war.

In an article in Time, December 7, 1981 FREDERIC GOLDEN writes in an article entitled "Fudging data for fun and profit" that "Findings that were touted only last summmer as a fundamental breakthrough in the understanding of carcinogenesis have been branded fraudulent". Charlatanism has been an inseparable companion of medicine over the years. Molecular Biology and Biochemistry are areas huge of study close to medicine and can hope for funding of research in the world of healing. The frauds of discovery at Cornell, Yale, Masschusetts General Hospital, Universities of Boston and California have been exposed. Costly experiments and costly computation in areas like high-energy physics and observational astronomy often lead to "breakthroughs" but it is a fact of life that these breakthroughs at any rate, many of them are forgotten with the passage of time. However, the breakthroughs recur again and again lest funding of projects should stop.

Big science is totally computerized today and computer fraud is the easiest among frauds. Any one choosing to falsify problems and data can resort to the total obfuscation of the computed statistics and analysis of data. In matters like genetic alteration and biological warfare the incubation time needed to expose the fraud is long and all those concerned with the frauds will be out of the scene by the time the fraud surfaces out.

6. computers delay basic research and thus reduce the field of applications in the future

Ptolemy the second century astronomer of Alexandria has compiled tables for the planetary system and these tables held the ground for a thousand years for comparison of abundant measured data with theory. It is now beyond doubt that the observations claimed to have been made by Ptolemy are indeed fudgings to fit into his theory and the way he went about fudging has been reconstructed. Plotemy´s system made factual frauds easy because it was a numerical scheme. Science is no more a collection of facts than a building is a heap of bricks. Science has to organize facts by reason so as to correlate what is or seems disjoint and to foreshadow facts that are not yet observed. Newton`s laws and Einstein´s theory of gravitation are not reducible to tables of numbers. They are mathematical ideas that are understood structurally first and then applied to instances. The slight correction of planetary orbits that Einstein´s theory provides is not its greatest merit. A small alteration in Newton´s scheme could have fitted it to the orbit of Mercury without altering the orbits it delivers for the other planets and that would have been adjustment of theory to fit the data. There was indeed a proposal to this effect. The emergence of Einstein´s theory was because of the conceptual inadequacy of Newton`s view of space-time and its incoherence with electromagnetism. The equations of motion of gravitatingbodies in Einstein´s theory arose as a product of the general revision of basic ideas. Newton´s scheme of the planetary system remains even now the basis of our ordinary thought regarding it in cosmology to a large extent.

Ptolemy´s understanding of the planetary system was a numerical state and in its kinetic essence it involves potentially as many adjustable entries as one chooses. In principle it could fit all the known planetary observations and could be refitted each time a new observation was made. The practical limitations on numerical calculations in Ptolemy´s days made fudgings necessary to secure agreement of theory with data and his system could have been adjusted to match perfectly with data for a thousand years after him but for the limits of numerical calculations. If calculating machines were in existence in KEPLER´s time astronomers would have no need or use for KEPLER´s laws of planetary motion for to them "the old way is more accurate". Had machines been available in Newton´s day he might have used them but would still have spent years on intense mathematical study of the planetary system. To predict the planetary motions with their

near regularity, methods of numerical interpolation and Ptolemy´s data might have sufficed. But interplanetary travel involves a body getting from one orbit to another and this is a totally different problem in which it is the irregularities that predominate. Computers of celestial orbits-even super computers-cannot cope with the determination of conditions for interplanetary transit, while operating within the method(s) of interpolation. The basic theories for transplantation might not have been accessible, had machines existed prior to or during the days of Newton, Euler and Lagrange, for astronomers would have in all likelihood settled for Ptolemy´s data and the adjustable parameters in his scheme.

Computers do promote science applications of known science; however obsession with them and the blind belief that they are panacea for all varieties of problems inhibits creation of new science and consequently drastically limits the realm of future applications of science.

The ravage on mathematics, thanks to the computer revolution is better understood by a simile due to FRAUENTHAL. In the early decades of this century BOHR and EINSTEIN brought about a revolution in Theoretical Physics and the tools used by them were such as those used earlier by Newton: viz., their minds applied to whatever physics they knew, aided ofcourse by whatever mathematics was known to them. There is not even a single evidence to infer that a computing machine would have helped them in their work

{ N = 15747724 13627500257760565 3 96118155
54680447 17914527 11670936 62314250
76185631 031296 = number of protons =

number of electrons in the universe - calculated (no use of any machine) by Eddington during an Atlantic Crossing)}

and they were content with simple calculations. It is edifying to recall the following statement of P.A.M. DIRAC (1939) "What makes the theory of relativity so acceptable to physicists ..... is its great mathematical beauty."

It is also pertinent to recall that the revolutions brought about by BOHR and EINSTEIN did not have motivation from the mistary interests and there was no funding from the Government on any industry. It is only in subsequent decades that this is marked accent on numerics as an essential part of physics.

"At present (29/August/1990, STEPHEN HAWKING - Lucasian Professor of Mathematics, University of Cabridge) computers are a useful aid in reasearch but they have to be directed by human minds. However, if one extrapolates their recent rapid rate of development, it would seem quite possible that they will take over altogether in theoretical physics. So may be the end is in sight for theoretical physicists if not for theoretical physics."

A breatheless pronouncement on theoretical physicists in deed. Computer addicts and high priests of computing are dead - earnest in preaching the same message with replacement of "theoretical physcists" by "mathematicians"

7. Computers promote logical fraud & computers programmed to confirm false theory can destroy mankind.

The war cry of huge computers has always been to reach more and more numerical problems that are always inadequate to understand the basics and bigger armaments * rise is demand to reinforce explanation of the basics. The situation is akin to that of a dictator ruling a country and clamouring for vesting of more and more powers in him for better governance of the country. In basic theories these are certain laws and principles and the results of any investigation are to be scrutinized in the light of such basic laws and principles. computers encourage only floating models which are not subject to any laws and this is sure to encourage logical fraud. Results deduced through unrigorous mathematics are not all that dangerous as long as the provision for a corrective through basic laws prevails sooner or later. Not so when there are no laws and all one has are floating models. Suppose that a new floating model is a good one but treating it mathematically is difficult and there is thus no assessment of the general qualities which applications of the model should have. The problems illustrating the model in important applications are put straight onto the computer with some simplificatory features legalizing them under the description "further approximations." Unrigorous mathematics paves the way for wrong answers to slip out even when the assumptions are right {c.f. the approximate evalution of exp (-5.5) through the use of the expansion of exp (x) and retetion of terms to the farthest possible extent on a machine.} In such a context unrigorous mathematics is indeed failed mathematics and hence it is fraudulent mathematics. Computerised fradulent mathematics opens the flood-gate for reserarch aimed at confirming what is already known or what ought to be true even if it is not. The computer can be programmed to support any "proclaimed truth." All this happens because of use lack of basic laws on which the theory has to seek susterance.

This situation is all right for fields that have only dogmas and no basic laws. A dogma is no theory meant for applications and the faithful invoke it as a was cry in all their activities. A revolution may replace one dogma by another, often the very opposite. Computerized floating models can always be adjusted to conform to any given dogma, no matter what the inputs are. The inputs may be maniputed to cancel out in the computing process.

The interest it [(Applied catastophic Theory) - H.J.SUSSMAN & R.S. ZAHLER:- Catastrophic Theory as applied to the social and biological sciences. A critique, (synthese 13 (1978), 117 - 216)] has aroused among the public at large is mostly understandable in terms of the fascination which the mystery of mathematics exerts upon the mathematically uneducated. Mathematics, in the perception of many, is like sorcery. The mathematicatian performs mysterious passes that others can not understand, and suddenly a prediction, a theory emerges... The statistical and behavioural data compiled by the mathematician after selection of the variables relevant to his problem - like growth and inflation in a particular economic environment and taking stock of the extraneous factors that may influence the economic climate are processed mathematically and through a computer to make precise forecasts of behaviour which are 'far superior to any that can be achieved with the best statistical techniques known" The actual nature of the mathematician's activity here is mysterious and resembles that of sorcerer, the * wand and flowing robes of the latter being replaced by the computer and the statistical data. The catastrophist is expected to make forcasts far superior to any that be achieved with the best statistical techniques, but there is not a single instance of such a forecast.

It seems to be the easiest thing in the world to apply for human betterment failed mathematics substantiated by experiments through the computer to confirm it. Such mathematics and computing can not transport man to the moon but will surely destroy every man and every woman on earth.

8. Computers are here to stay. They endanger thought, language and science and indeed the survival of man. They must be put under strict control.

Like a Bofors gun or a television network a computer is an object and by itself, it is neither good or bad. Like nuclear fission it can be useful or dangerous like the mike for amplified relay of music concerts, the computer has come to stay and one has to thank it for its useful role in space travel, and many other applied science programmes. How about

men around the computer ? Well, most men are good and it is possible we as a race are on the threshold of a golden era of peaceful coexistance of man with man. Computers will stay as long as man can make and run them or until he replaces it by something even more powerful. But the smartest of computers with the most powerful language acceptable to it, can deal only with object codes comprising solely of ones and zeros that are finite in number. If a problem is demonstrably amenable to finite arithmatic, a computer is useful and can be used in a preliminary exploration of certain mathematical problems, especially in optimization problems. But numerics do not provide or constitute an understanding of the structure of a scientific problem without the prior understanding of possible structures conjuectured from case studies and followed by logical construction. Computation is acceptable and useful in providing details concerning problems whose structure is already mathematically understood. The importance of numerics to science has been brazenly exaggerated by pressure groups motivated by interests of trade and profit and computer addicts have come to believe computing to be the first and last command of Providence. Prepondence of computation discourages critical analysis and creative thinking. Critical analysis and creative thinking are as important to-day as they were in the before - computer era and intellectual science of the human mind is to be cherished and fostered always.

Of all human capacities language and writing are the noblest and adulteration of language is indeed the debasement of the dignity of man. Freedom consists in the ever present choice of defiance of tyranny and language as the total medium of expression is the sole means of that defiance. The abridgement of the structure and form of language by the institution of arbitrary but totally inflexible rules constitutes a threat to freedom. In a way the grammar of any language also does that but speaking the machine language subject to its grammar is a censorship and supression of spontaniety of modes of expression and denial of human elements in speech and gesture is no small price that man pays for the utility of the machine. The tyranny to man from the machine is total because communication to the machine is private and closed to spectators. The machine is utterly devoid of feeling and defiance before an oppressor who understands not defiance is a wasteful cry. In communicating with machine´s intelligence man´s consicousness volunatrily subjects itself to captivity and suspends its natural operations. An individual so professionally disciplined as to

entertain lasting enjoyment in the company of machine intelligence is condemned to moonlighting as a disciple of the oracle of BITS and BYTES. Should the planet earth be ruled by such experts of machine intelligence in the future, one will not know who the masters are. When the medium becomes the message, those messages which were previously medium will devour genuine messages.

Had not the appalling failure of a computer been corrected by human steadiness and human action, a horrendous nuclear war would have precipitated in the early eighties. Art Buchward wrote in the International Herald - Tribune (14/15, June 1980)

"... war is too serious a business to be left to computers." The dangers potential in application of such sciences as high-energy physcis and genetic alteration are also serious and cannot be left to computers. To remove critical and creative use of human language and human reson is the greatest among the many threats to the survival of mankind. The computer should not be allowed to become a Satanic instrument.

In the article "To teach or not to teach" [Am: J. Physics 59, No6 (June 1991] Freeman J. Dyson Laments about the damage that the Ph.D System is doing to creative science and states. "I would like to give everybody a Ph.D at birth, or on the day they enter graduate school so that the Ph.D would no longer be an obstacle to education or to scientific employment." The damage that the computer has inflicted on man is indeed considerable but there is no simple remedy like the above recommended by Dyson. The least is that the computer is put under strict controls and a modified "Bers Principle" is guaranteed viz., "God watches over the computer addicts and patrons" Let us hope. He continues to do so.

ABUSE OF THE COMPUTER

(a) A computer cannot set its own standards; calculation without standards is dangerous and may turn out to be a wild goose chase.

(b) Spatial flight would have been impossible without the computer; equally true it is that the programme would not have started without the classic theory of mechanics inaugurated by NEWTON (1642-1727), organised by EULER (1707-1785) and systematized by LAGRANGE (1736-1813).

(c) Mathematics is the science of infinities and of limiting processes. Computation is essentially finite. Classic Theories in physical science use inductive and deductive models. Computer uses a floating model.

(d) Computer brings power and with it also the abuse of power. Advocates of computation destroy mathematics.

(e) Computers have harmed science; have promobed factual fraud; have damaged experimental and applied science.

(f) Computers delay basic research and thus reduce the field of applications in the future.

(g) Computing promotes logical fraud. Computers programmed to confirm false theory can destroy mankind.

(h) Computers are here to stay. They endanger human thought, language, science and the very survival of man.

BERS PRINCIPLE

God watch es over applied mathematicians. Let us hope HE continues to do do. - (Computer - MANIAC - (the biggest at the time)- programmed to solve a problem of a TYPE classical in gas dynamics and known to lead to a catastrophe after a finite tune)

E.FERMI, J.PASTA and S.VLAM - to find a system that shows a gradual, continuous flow of energy from the first mode to the higher modes.

(1) Start: a simple harmonic assembly which conserves the energy of each mode forever.

(2) Introduce hypothetical nonlinear forces acting between neighbouring points.

(3) Several special members of a class of p.d.e.- well studied from 1845 onwards. Proceed to the biggest computer MANIAC. - Long and costly computations - showed "features which were, from the beginning, surprising ...."

Results reported and reference to "limits guaranteed by the ergodic theorem" (1955).

N.J.ZABUSKY (1962) - use of the standard hodograph transformation => a linear hyperbolic system thoroughly investigated by RIEMANN (186Ø) - after a finite time the solution ceases to exist - outcome is a shock wave - a catastrophe.-

Computer solution of FERMI ET AL suspect because of the floating origin of the discrete problem.

M.D.KRUSKAL (1974) replaced the problems (the computer code was designed to solve but could not solve) by one that the computer did solve.

Nonlinear waves which pass through each other with no change of form. SOLITONS (single solitary ways - known and well studied in classical hydrodynamics for a long time before the project was started).

OBSERVATIONS

1. The programme given to the computer was incorrect for the analytical problem to be solved.

2. The correct solution of the analytical problem predicts a catastrophe - what a tradegy it would have been if the problem concerned a real nuclear reactor and the smooth and safe solution of the computer was applied to the real world.

3. Results of computation were a disappointment. The correct solution was a still greater disappointment. The problem was replaced by one that the computer could solve.

4. The new problem also had a classic foundation and was well understood already. - A case of hectic, unprincipled floundering. All is well that ends well. Hundreds of mathematical papers on the harmless, beautiful topic of classical hydrodynamics - SOLITON.

BERS Principle in Action.